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Mathematics Content Knowledge, Anxiety, and Efficacy Among Traditional and Alternative Certification Elementary School Teachers

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MATHEMATICS CONTENT KNOWLEDGE, ANXIETY, AND EFFICACY AMONG TRADITIONAL AND ALTERNATIVE CERTIFICATION ELEMENTARY SCHOOL TEACHERS

The purpose of this study was to understand mathematical content knowledge, anxiety, and efficacy for mathematics elementary school traditional and alternative certification preservice and in-service teachers. The teachers in this study were given mathematics content examinations and mathematics anxiety and efficacy questionnaires in reform-based mathematics methods. Additionally, teachers were required to keep reflective teaching and learning journals throughout the semester. It was found that there were increases in content knowledge and efficacy, but not anxiety levels, over the course of the semester. There were no differences between traditional and alternative certification teachers in content knowledge, anxiety, and efficacy.

Key words: teacher education- teaching and learning

Mathematical content knowledge, anxiety, and teacher efficacy are important measures of teacher quality. Teacher content knowledge is important because it is directly related to student achievement (Hill, Rowan, & Ball, 2005). Mathematics anxiety is defined by Richardson and Suinn (1972) as the feeling of "tension and anxiety that interfere[s] with the manipulation of numbers and the solving of mathematical problems in a wide variety of life and academic settings" (Suinn & Winston, 2003, p. 167). Efficacy is a teacher's belief in his or her ability to teach effectively and positively affect student learning outcomes (Bandura, 1986; Enochs, Smith, & Huinker, 2000), and it is an important component for successful teaching.

Theoretical Framework

Ball, Hill, and Bass (2005) emphasized the importance of strong content knowledge for elementary school teachers. Ma (1999) found an inverse relationship between mathematics anxiety and achievement in mathematics. One theoretical explanatory model contends that anxiety interferes with the recall of prior mathematical knowledge and thus hinders the person from performing well (Ma, 1999). Bandura (1986) found that teacher efficacy can be subdivided into a teacher's belief in his or her ability to teach effectively, and his or her belief in affecting student learning outcomes despite external factors.

Research Questions

1. What differences existed between teachers' mathematical content knowledge, anxiety, and efficacy before and after an elementary mathematics methods course?
2. Were there differences in mathematical content knowledge, anxiety, and efficacy between traditional and alternative certification teachers?
3. What were teachers' beliefs about teaching and learning mathematics?

Methodology

The methodology of this study involved both quantitative and qualitative methods. The sample in this study consisted of 65 teachers in a traditional ($N = 28$) and alternative certification ($N = 37$) master's degree program. About 25% of the participants were male and about 75% of the participants were female. Participants were enrolled in three reform-based elementary mathematics methods sections that involved both pedagogical and content instruction and emphasized learning through an inquiry approach. Teachers were given mathematics content

examinations and anxiety and efficacy questionnaires at the beginning and the end of the semester.

The mathematics anxiety questionnaire was adapted from the brief version of the Mathematics Anxiety Rating Scale (MARS) developed by Suinn and Winston (2003) based upon the original MARS created by Richardson and Suinn (1972). The efficacy questionnaire was the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) developed by Enochs et al. (2000), and measured concepts of teacher efficacy. The MTEBI contained two subscales: Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE) with 13 and 8 items, respectively. Teachers were required to keep reflective journals on their teaching and learning over the course of the semester, which provided qualitative data regarding their attitudes toward teaching and learning mathematics. The teaching and learning journals had four entries each, one for each month of the semester.

Results

Research question one was answered using paired samples *t*-tests (see Table 1). There were statistically significant increases found over the semester for the mathematics content test, PMTE, and MTOE. However, no statistically significant difference was found for MARS. The mathematics content test had a large effect size, while the efficacy measures had small to medium effect sizes.

Table 1
Paired Samples t-Test Results on Content, Anxiety, and Efficacy

Assessment	Mean	SD	*t*-value	*d*-value
Mathematics Content Pre-Test	68.08	18.555	-9.096**	1.081
Mathematics Content Post-Test	86.08	14.510		
MARS Pre-Test	3.43	0.752	-0.758	
MARS Post-Test	3.49	0.611		
PMTE Pre-Test	3.51	0.615	-3.062**	0.382
PMTE Post-Test	3.72	0.479		
MTOE Pre-Test	3.52	0.484	-3.351**	0.460
MTOE Post-Test	3.74	0.473		

Note. $N = 65$, $df = 64$, two-tailed
** $p < 0.01$

Research question two was answered using independent samples *t*-tests (see Table 2). There were no statistically significant differences found between traditional students and alternative certification students. The closest variable to statistical significance was a difference

between the traditional and alternative certification teachers on the MTOE post-test. The *p*-value was 0.083, and hence significant only at the 0.10 level.

Table 2
Independent Samples t-Test Results on Content, Anxiety, and Efficacy

Assessment	Mean	SD	*t*-value
Mathematics Content Pre-Test			
Traditional	64.64	16.212	-1.305
Alternative	70.68	19.971	
Mathematics Content Post-Test			
Traditional	85.54	15.416	-0.206
Alternative	86.49	13.987	
MARS Pre-Test			
Traditional	3.31	0.729	-1.040
Alternative	3.51	0.768	
MARS Post-Test			
Traditional	3.47	0.644	-0.174
Alternative	3.50	0.593	
PMTE Pre-Test			
Traditional	3.60	0.597	1.045
Alternative	3.44	0.627	
PMTE Post-Test			
Traditional	3.77	0.504	0.633
Alternative	3.69	0.463	
MTOE Pre-Test			
Traditional	3.53	0.521	0.228
Alternative	3.50	0.462	
MTOE Post-Test			
Traditional	3.86	0.460	1.759
Alternative	3.65	0.470	

Note. $N = 65$, $df = 63$, two-tailed

Research question three was answered using teacher reflections. The teaching journals revealed teachers found the lack of student conceptual understanding to be one of the biggest issues for them. Some teachers mentioned classroom management problems, but not as many teachers expressed this concern as would be expected. The learning journals revealed that the teachers found the course's emphasis on problem solving, conceptual understanding, real-world connections, and teaching using technology and manipulatives to be most helpful.

Discussion

It was found that over the course of a graduate level reform-based mathematics methods course preservice and in-service teachers had an increase in mathematical content knowledge and efficacy, both in terms of personal concepts of effective teaching and student outcome expectancy. Many teachers indicated a decrease in mathematics anxiety and a gain in their own mathematical confidence in their reflective journals, but it was surprising that results from the MARS instrument did not indicate this.

No differences were found between traditional and alternative certification teachers for mathematics content knowledge, anxiety, or efficacy. However, there was a difference in student outcome expectancy on the post-test between traditional and alternative certification teachers at the 0.10 level. This should be further investigated.

Findings in this study indicated that a reform-based methods course, coupled with field experiences, can improve teacher mathematical content knowledge and efficacy. In order to ensure that the students are receiving the best possible educations, further studies on teacher quality and student success are needed in this context.

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